FROM PIXELS, VIA VOXELS TOWARD DYNAMIC OBJECTS: CURRENT TRENDS IN ANALYSIS AND VISUALISATION FOR THE NEUROSCIENCES.

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The last decade has seen the rapid proliferation of devices (eg. MRI, CT, PET, Optical Sectioning Microscopes) which can output serial sequences of registered greyscale images. These images represent thin sections though the volume object under investigation. Serial 2D sections are in themselves indispensable for making measurements and for helping to reveal the internal structure of volume: but the development of new software and hardware techniques to exploit 2D (and 21/2D) analysis of volume data has now almost stopped. On the other hand, the whole stack of 2D slices constitutes a single point-sampled 3D data set, and it is clear that there can real advantages to be gained from treating the data volume as a single entity. In fact, a repeated-measures study of a single specimen provides a single 4D data set, and in multi-label fluorescent microscopy or multi-attribute MRI, the data can be 5-dimensional. Among the benefits of going directly to interactive multi-dimensional visualisation and analysis are:

** comprehensive insight into dynamic structures
** efficient handling of population studies
** fast appreciation of subtle structure
** accurate volume measurements, structure recognition
** improved spatial resolution by degradation-reversal.

The appearance of a new class of software tool to handle this type of data marks a significant move away from a predominantly visualisation-orientated approach toward one in which interactive voxel-based visualisation, segmentation and model-making functionality become intertwined. An example would be Fairfield's adaptive-refinement volumetric renderer in which the user controls the way in which the size of the constituent voxels depends on local grey-scale variance.Sharply rising performance/price ratios for standard graphics workstation hardware, plus increasing end-user expectations for software quality and functionality are now spelling the end of the current era, in which 2D software tools are predominantly used to work with the multidimensional data from volume-scanning instruments.

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